CHAPTER 10

INSTALLATION OF DISK DRIVES

INTRODUCTION

The storage device is the most important component in the computer system. A storage device uses magnetic or solid state media. Disks, tapes, and diskettes use magnetic media. CD-ROM and DVD use optical media, and removable flash memory card is an example of solid state media.

Hard disk drive (HDD) is the most popular storage medium used in modern computers for storing and accessing data. HDD has a large storage capacity and is cheaper. It can be attached internally inside the cabinet as well as can be connected externally to the computer. It supports rapid access to random data locations, meaning that data can be written or retrieved quickly for a large number of simultaneous users or applications.

OVERVIEW OF HARD DISK DRIVE (HDD)

It is the primary long-term storage device used in personal computers. A hard disk drive fits inside a computer case and is firmly attached with the use of braces and screws to prevent it from being jarred as it spins. Typically it spins at 5,400 to 15,000 RPM. The disk moves at an accelerated rate, allowing data to be accessed immediately. Most hard drives operate on high speed interfaces using serial attached technology (SATA). When the platters rotate, an arm with a read/write head extends across the platters. The arm writes new data to the platters and reads data from them. Most hard drives use Enhanced Integrated Drive Electronics (EIDE) including cables and connectors to the motherboard. All data is stored magnetically, allowing information to be saved when power is shut off.

A hard drive is divided into one or more partitions, which can be further divided into logical drives or volumes. Usually a Master Boot Record (MBR) found at the beginning of the hard drive, which contains a table of partition information. Each logical drive contains a boot record, a File Allocation Table (FAT) and a root directory for FAT file system or any other file system. The HDD can be internal (fixed) or external.

Fig. 10.1: Hard disk drive

Internal or Fixed HDD

Almost every computer has a fixed HDD. A fixed HDD is built into the case of a computer. It is the main backing storage device of computers since it provides instant and random access to data with high access speed.

External or Portable HDD

A portable HDD can be attached to the computer externally through USB. It is used to store very large amount of data and easy to use in computer just by plugging it in the USB port of computer.

Physical Components of HDD

A hard disk drive uses a rapidly moving arm to read and write data across a flat platter coated with magnetic particles. Data is transferred from the magnetic platter through the read/write (R/W) head to computer. Several platters are assembled together with the R/W head and controller. Data can be recorded and erased on a magnetic disk any number of times.

Key components of a disk drive are platter, spindle, read/write head, actuator arm assembly, and controller (Figure 10.2).

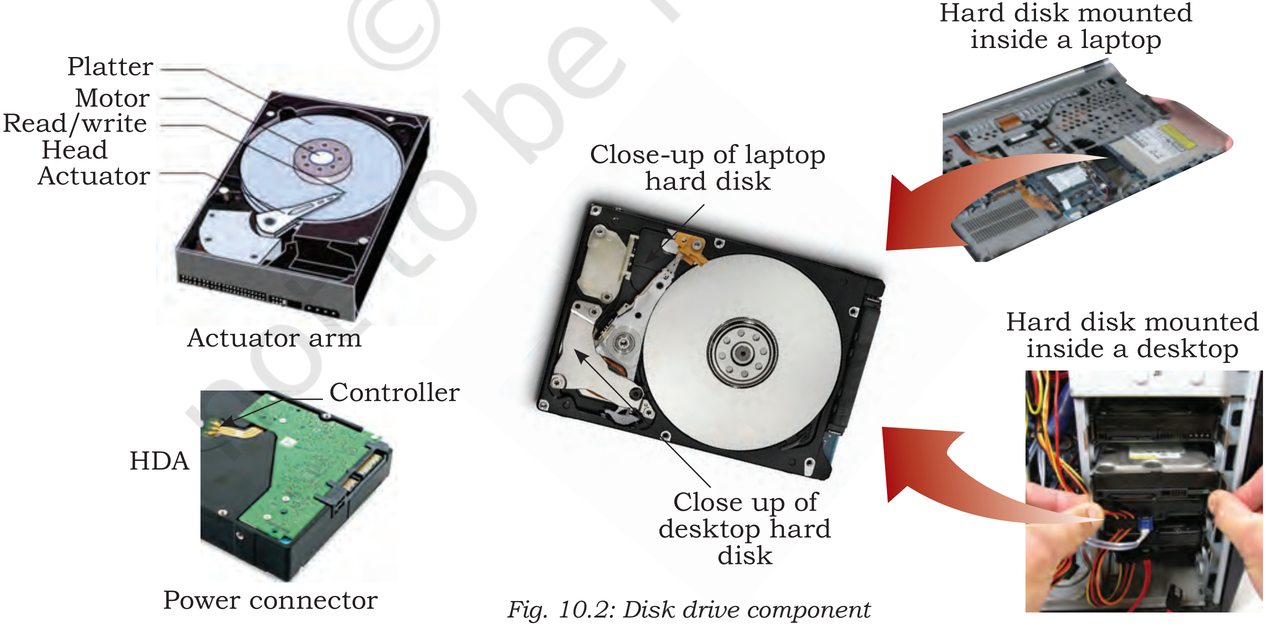

Platter
Motor
Read/write Head
Actuator
Actuator arm
Controller
HDA
Power connector
Close-up of laptop hard disk
Close up of desktop hard disk
Hard disk mounted inside a laptop
Hard disk mounted inside a desktop

Fig. 10.2: Disk drive component

Platters

A HDD consists of multiple flat circular disks called platters. The data is recorded on these platters in binary codes (0s and 1s). The set of rotating platters is sealed in a case, called a head disk assembly (HDA). A platter is a rigid, round disk coated with magnetic material on top and bottom surfaces. Data can be written to or read from both surfaces of the platter. The number of platters and the storage capacity of each platter determines the total capacity of the drive.

Spindle

It connects all the platters, and is connected to a motor as shown in Figure 10.3. The motor of the spindle rotates with a constant speed. The disk platter spins at a speed of several thousands of revolutions per minute (rpm). Disk drives have spindle speeds of 7,200 rpm, 10,000 rpm, or 15,000 rpm. Disks used on current storage systems have a platter diameter of 3.5” (90 mm). When the platter spins at 15,000 rpm, the outer edge is moving at around 25 percent of the speed of sound. The speed of the platter is increasing with improvements in technology, although the extent to which it can be improved is limited.

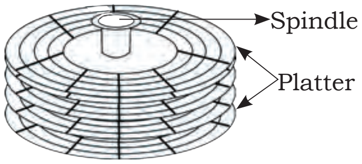


Fig.10.3: Spindle and platter

Read/write head

Read/write (R/W) heads, read and write data from or to a platter. Drives have two R/W heads per platter, one for each surface of the platter. The R/W head changes the magnetic polarisation on the surface of the platter when writing data. While reading data, this head detects magnetic polarisation on the surface of the platter. During read and write, the R/W head senses the magnetic polarisation and never touches the surface of the platter. When the spindle is rotating, there is a microscopic air gap between the R/W heads and the platters, known as the head flying height. This air gap is removed when the spindle stops rotating and the R/W head rests on a special area on the platter near the spindle. This area is called the landing zone. The landing zone is coated with a lubricant to reduce friction between the head and the platter. The logic on the disk drive ensures that heads are moved to the landing zone before they touch the surface. If the drive malfunctions and the R/W head accidentally touches the surface of the platter outside the landing zone, a head crash occurs. In a head crash, the magnetic coating on the platter is scratched and may cause damage to the R/W head. A head crash generally results in data loss.

Actuator arm assembly

The R/W heads are mounted on the actuator arm assembly, which positions the R/W head at the location on the platter where the data needs to be written or read. The R/W heads for all platters on a drive are attached to one actuator arm assembly and move across the platters simultaneously. There are two R/W heads per platter one for each surface.

Controller

The controller is a printed circuit board, mounted at the bottom of a disk drive. It consists of a microprocessor, internal memory, circuitry, and firmware. The firmware controls power of spindle and speed of motor. It also manages communication between the drive and the host. In addition, it controls the R/W operations by moving the actuator arm and switching between different R/W heads and performs the optimisation of data access.

Logical Components of HDD

Tracks

Each platter of the hard disk is logically divided into many concentric circles known as tracks. The data gets stored on these tracks. On a 3.5 inch hard disk, there are thousands of tracks. The tracks are numbered, starting from zero, from the outer edge of the platter. The outermost track is 0 and the innermost track has the highest number. When the head is positioned over a track, it can read or write data on the track as the platter spins.

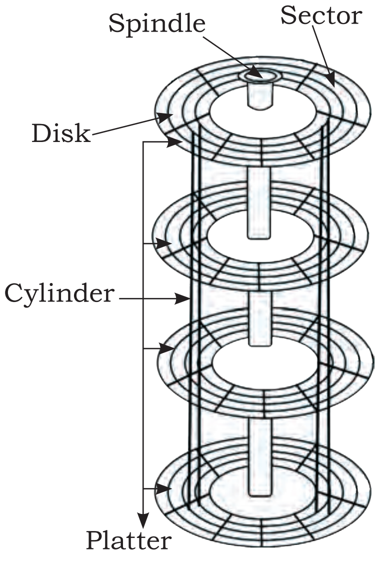


Fig. 10.4: Disk structure: sector, tracks, and cylinders

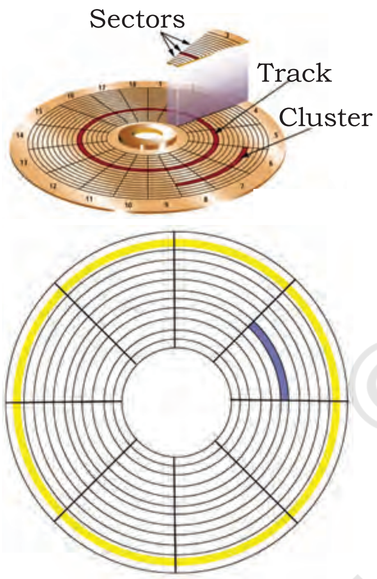


Fig. 10.5: Tracks and sectors

Cylinders

A cylinder is the set of identical tracks on both surfaces of each drive platter. The location of drive heads is referred to by a cylinder number, not by track number. In a hard disk, the data is stored in a cylinder by cylinder method.

If the disk holds 1024 cylinders then the second last cylinder consists of all the tracks at the innermost edge of each side. The tracks near the outer portion of the disk are less densely populated than the tracks located near the center of the disk.

Sectors

Each track is logically divided into sections known as sectors. A sector is the smallest physical storage unit on the disk. It has a data size of power two and usually has 512 bytes storage capacity. Every track has the same number of sectors.

In addition to user data, a sector also stores other information, such as sector number, head number or platter number, and track number. This information helps the controller to locate the data on the drive, but storing this information consumes space on the disk. Hence, there is a difference between the capacity of formatted and unformatted disk. A disk of 500 GB capacity will hold 465.7GB of user data and the remaining 34.3GB is used for metadata.

Clusters

This is a group of multiple sectors. The file system allocates the number of clusters to store file data. Suppose, if each cluster is 512 bytes and file capacity is 800 bytes, then the file system allocates two clusters for the file.

Files

These are written to clusters. If the file is bigger than a single cluster, the file is written to multiple contiguous clusters. However, if other data is already written on an adjoining cluster, the file is fragmented and written to another available cluster.

Working of Hard Disk

The data on the hard disk is stored in the magnetic domains on the magnetic material. It performs the recording function through its concentric circles or tracks.

When you initiate a command to store some data on the disk, the data flows into a cache. From there, the data is encoded using mathematically derived formulae. This is done to detect and correct the possible errors from the data.

Further, free sectors on the disk are selected. Then the actuator moves the heads over those free sectors. These processes are followed just before the writing function.

When the writing time arrives, a pattern of electrical pulses pass through the writing element coil. This process produces a related pattern of magnetic fields. The fields alter the magnetic orientations of bits and as a result, the bits represent the data.

The reading process continues in a reverse direction. After consulting the locations of the stored data, the actuator moves the head over those tracks, wherein the chosen data is located.

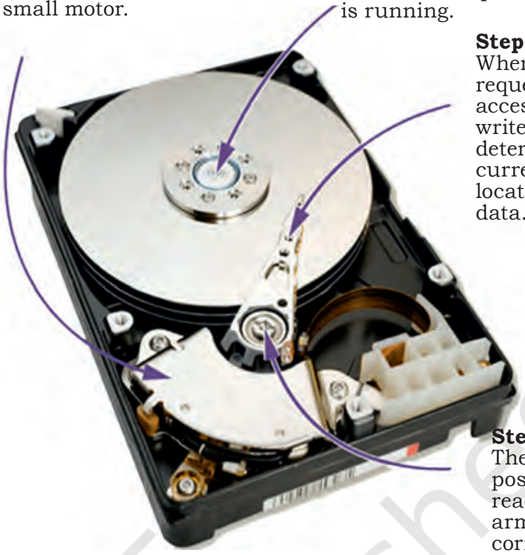
When the sectors receive the correct sensors, the magnetic fields from the bits induce resistivity changes. The changes locate the reading elements. The elements are further connected to electronic circuits. When the current flows from the electronic circuits, it helps in decoding the data stored in the disk.

How a hard disk works

Step 1: The circuit board controls the movement of the head actuator and a small motor.

Step 2: A small motor spins the platters while the computer is running.

Step 3: When software request disk access, the read/write heads determine the current or new location of the data.



Step 4: The head actuator positions the read/write head arms over the correct location on the platter to read or write data.

Fig. 10.6: Working of hard disk

Disk Drive Performance

A disk drive is an electromechanical device that governs the overall performance of the storage system environment. The various factors that affect the performance of disk drives are seek time, rotational latency, and data transfer rate.

Seek time

The seek time, also called access time, describes the time taken to position the R/W heads across the platter with a radial movement moving along the radius of the platter. It is time taken to find and send the first byte of the file to CPU. The average seek time on a modern disk is typically in the range of 3 to 15 milliseconds. It has more impact on the read operation of random tracks rather than adjacent tracks. To minimise the seek time, data can be written to only a subset of the available cylinders. This results in lower usable capacity than the actual capacity of the drive. For example, a 500 GB disk drive is set up to use only the first 40 per cent of the cylinders and is effectively treated as a 200 GB drive. This is known as short-stroking the drive.

Rotational latency

To access data, the actuator arm moves the R/W head over the platter to a particular track while the platter spins to position the requested sector under the R/W head. The time taken by the platter to rotate and position the data under the R/W head is called rotational latency. This latency depends on the rotation speed of the spindle and is measured in milliseconds. The average rotational latency is one-half of the time taken for a full rotation. Similar to the seek time, rotational latency has more impact on the reading/writing of random sectors on the disk than on the same operations on adjacent sectors.

Average rotational latency is around 5.5 ms for a 5,400-rpm drive, and 2.0 ms for a 15,000-rpm drive.

Data transfer rate

The data rate is the number of bytes per second that the drive can deliver to the CPU. Rates between 5 and 40 megabytes per second are common.

To understand the data transfer rate, you need to first understand the process of read and write operations. In a read operation, the data first moves from disk platters to R/W heads, and then it moves to the drive's internal buffer. In a write operation, the data moves from internal buffer to the R/W heads. Finally, it moves from the R/W heads to the platters.

The data transfer rates during the R/W operations are measured in terms of internal and external transfer rates, as shown in Figure 10.7.

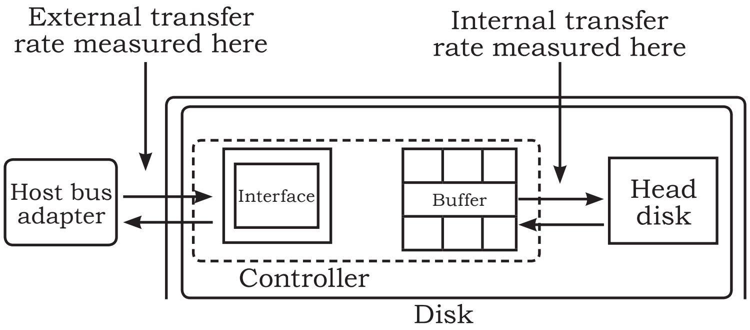

External transfer rate measured here
Internal transfer rate measured here
Host bus adapter
Interface
Buffer
Head disk
Controller
Disk

Fig. 10.7: Data transfer rate

Types of HDD

The various types HDD such as, IDE or PATA drives, SATA, SCSI drives are explained below.

IDE drives

The IDE drives or PATA drives is an old technology. It used 40 or 80 pin wide ribbon cables to transfer multiple bits of data. It's data transfer rate was 133 MB/sec. PATA cables were used to connect these drives.

SATA drives

SATA (serial advance technology attachment) are new and currently used drives. These drives have generally seven pins made available with 1 meter data cable. our of seven, four pins are used for sending and receiving data and other three are grounded. It starts with the data transfer rate from 1.5 Gbits/sec. Currently, the fastest drive offers 16 Gbits/sec. SATA cables are used to connect SATA drives. Only one drive can be connected with single data cable. These drives operate with 250 mV. Three generations of SATA are currently in use. The table below outlines the different versions and their speeds.

Table 10.1 Different versions of SATA hard disks

Generation	Bit speed	Byte Speed	Names
SATA1	1.5 Gbits/s	150 MBps	SATA 1.5G, SATA 1.5Gb/s, SATA 1.5Gbits/s, SATA 1.50
SATA2	3.0 Gbits/s	300 MBps	SATA 3G, SATA 3Gb/s, SATA 3 Gbit/s, SATA 300
SATA3	6.0 Gbits/s	600 MBps	SATA 6G, SATA 6Gb/s, SATA 6Gbit/s, SATA 600

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SCSI drives

The small computer system interfaces (SCSI) are among the fastest drives. These drives can be installed both internally and externally. The SCSI drives usually carry 5068 pins. Currently it offers data transfer rate of 3 Gbits/sec. SCSI cables are used to connect these drives.

SCSI-1 (also called narrow SCSI)

Uses a 50-pin cable with a maximum transfer rate of 5 Mbps. Narrow SCSI uses an 8-bit bus and supports a maximum of 8 devices.

SCSI-2

Uses a 25-pin, 50-pin, or 68-pin cable. This was first called fast SCSI because it could transfer data at 10 MBps, twice as fast as SCSI-1. It originally used an 8-bit bus. Fast-wide SCSI is an update that uses a 16-bit bus and supports 16 devices with transfer rates of 20 MBps.

Single connector attachment (SCA)/SCSI-3

SCSI-3 is also called Ultra SCSI and includes several different versions.

SAS drives

Serial attached SCSI (SA) drive is an evolution of parallel SCSI into a point-to-point serial peripheral interface in which controllers are linked directly to disk drives. These drives rotate much faster than SATA drives. Generally, they work twice as fast as the SATA drives. SAS is a performance improvement over traditional SCSI because SAS enables multiple devices (up to 128) of different sizes and types, to be connected simultaneously with thinner and longer cables; its full-duplex signal transmission supports 3.0 Gbits/sec.

Hard Drive Characteristics

As you know that the HDD comes in various sizes, storage capacity, and different types of connectivity. This factor forms the characteristics of HDD. The following are some of the important characteristics of HDD:

Storage capacity

The physical size of the HDD is either 2.5 inch or 3.5 inch. The storage capacity of the HDD is listed as GB or TB. The storage capacity of present HDDs is 500 GB or 1 TB.

Hard drive speeds

The hard drive's speed is measured in terms of its rotation per minute (rpm). Most commonly, the HDDs are available in 5,400, 7,200, 10,000, and 15,000 rpm. Drives with 7,200 rpm are used in standard desktop computers. Other factors also contribute to the speed. For example, seek time refers to the average amount of time it takes to move the read/write head from one track to another track, and lower seek times are better. If you find two drives of the same size with the same rpm speed but one is significantly cheaper, it might be due to a higher seek time, resulting in overall slower performance. The interface can also limit the speed. Imagine a drive spinning at 15,000 rpm with a low seek time. It can read and write data to and from the hard drive, but it is limited as to how much data can actually be transferred between the hard drive and other computer components. The following sections describe common interfaces.

Interface

The interface is how HDD is connected to the system. There are internal HDD and external or portable HDD. The internal HDD is connected by using SATA cable. One end of the connector is connected to the HDD and other end to the power supply unit. The external HDD are connected to the computer system by using USB port, FireWire port, eSATAp port, and RJ-45 Ethernet port.

SCSI cables and connectors come in several different versions. Some are ribbon cables similar to the cables used with PATA drives, and other cables are round. Some examples of SCSI connectors are:

(i) 25-pin: This is a very old SCSI connector, also known as a DB25. It has one row of 13 pins and a second row of 12 pins.

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(ii) 50-pin: Several types of 50-pin SCSI connectors have been used. Some have two rows, and some have three rows. A Centronics 50-pin connector has connectors lined up in slots.

(iii) 68-pin: This includes two rows of pins close together and is referred to as high-density. It is sometimes used for external SCSI connections.

(iv) 80-pin: This is known as a single connector attachment (SCA) connection, and it is used as an alternative to 68-pin connections. It includes pins for both data and power and supports hot-swapping.

Practical Activity

Connect external HDD in different ways to the computer.

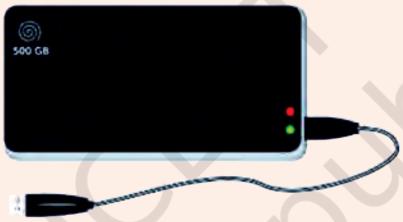

Fig. 1: USB connection HDD

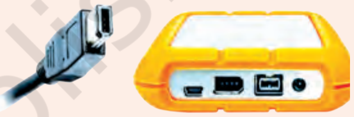

Fig. 2: Fire wire connector with external HDD

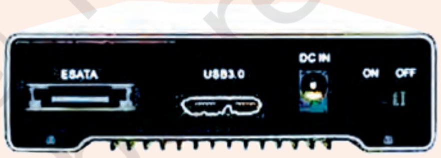

Fig. 3: eSATA Port to connect HDD

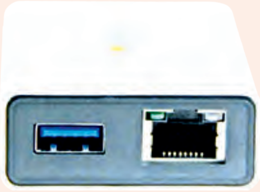

Fig. 4: RJ-45 Ethernet port to connect HDD

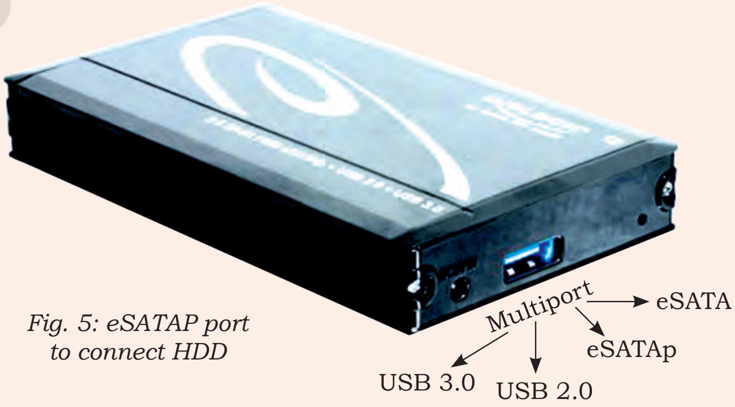

Fig. 5: eSATAP port to connect HDD

Installation of Internal HDD

The process of installing an internal hard drive involves mounting it and connecting a couple of cables.

Drive cages, bays, and mounting options

Internal 3.5-inch hard disk drives are mounted in a drive cage or drive bay. Placement and orientation of the cages or bays will vary from case to case. Drive cages/bays will most often be mounted perpendicular to the bottom of the chassis, while drives mounted in the cages usually sit parallel to the bottom of the case. The drive connectors are on the rear side of the hard disk drive.

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Practical Activity

Installation of internal HDD in a computer

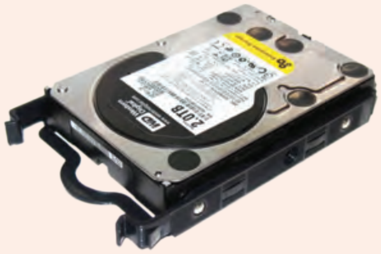


Fig. 1: Hard drive with tool less brackets

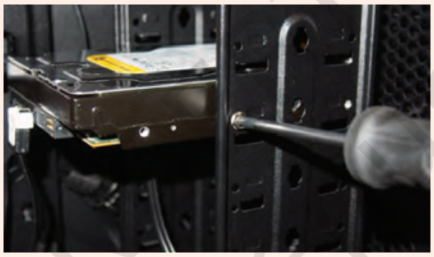


Fig. 2: Screwing the hard disk drive

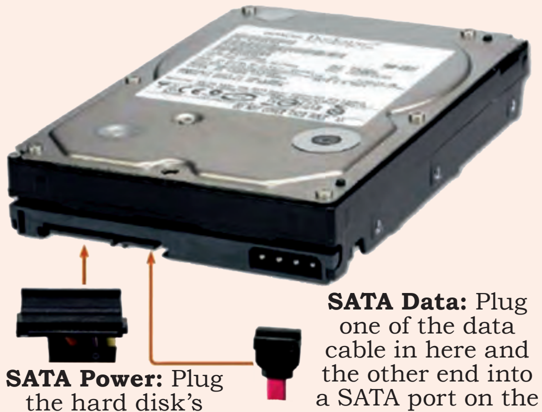
Step 1: Fit hard disk into a bay.

To fit a hard disk, identify a spare 3.5 inch drive bay. Four screws are required to secure the drive to a cage on the sides or bottom of the drive. Some drives have screw less fittings. Such hard drive come with tool-less brackets that make mounting hard drives easy. Slide the hard disk into a spare drive bay until the screw holes in the side of the drive line up with the holes in the drive bay. Then secure the disk with four screws, two on either side. Use magnet-tipped screw drivers. The screws are provided with the hard disk or case. Screw them tightly to prevent the drive.

When mounting drives in a system, try to leave as much space between them as possible to maximise airflow over the tops and bottoms. Positioning the drives directly in front of an intake fan also helps.

Step 2: Connect the hard drives with SATA.

Once the drive is mounted, connect it to system. The SATA interface hard drive uses SATA cables. One end of SATA cable is connected to the hard drive and other end to motherboard connector.


SATA Power: Plug the hard disk's power in here.

SATA Data: Plug one of the data cable in here and the other end into a SATA port on the motherboard.

Fig. 3: SATA data and power cable port on hard drive

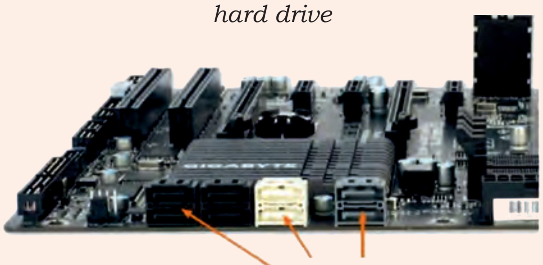

SATA Ports: These are for hard disks, newer DVD writers and Blu-ray drives, SATA3 ports, if available, are for hard disks and SSDs.

Fig. 4: SATA port on motherboard

Step 3: Plug in SATA power.
Locate the correct connector from power supply unit (PSU) and plug it into the back of the hard disk. Be careful when plugging it in, as downward pressure can break the clip surrounding the power connector.

Step 4: Plug in SATA data cable.
Unlike IDE, SATA uses a simple and thin connector to carry data. The motherboard has several SATA cables. Take one of these and plug it gently into the rear of the hard disk. Be careful to plug it in, as downward pressure can break the connector and prevent the SATA cable plugging in.

Step 5. Plug SATA data cable into motherboard.
Next, find a spare SATA port on motherboard. These are usually located at the bottom-right of the board and are numbered. The lowest number has the higher boot order in case of multiple disk. So plug the SATA cable into the lowest-numbered port.

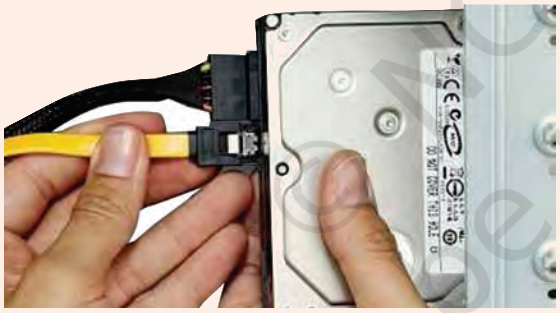


Fig. 5: Connecting SATA-data cable

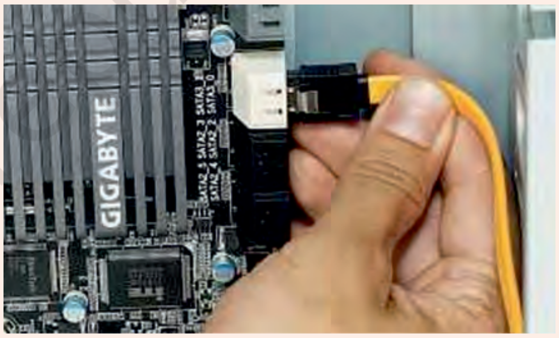


Fig. 6: Plugging SATA data cable into the motherboard

Practical Activity

Installing HDD in a laptop

Different laptops have different methods for accessing the storage drive.

Material required

Laptop, mini screwdriver, anti-static wrist strap, magnifying glass.

Procedure

There are several types of small screws that are used throughout the laptop. Place these in small envelopes and write the component name on the envelope. Be organised and keep track of all the screws. We have to figure out how to remove the back panel.

Step 1: Start the disassembly process by removing the battery.

Turn the notebook upside down and remove all screws securing the bottom case.

There are two screws (green circles) hidden under bottom.

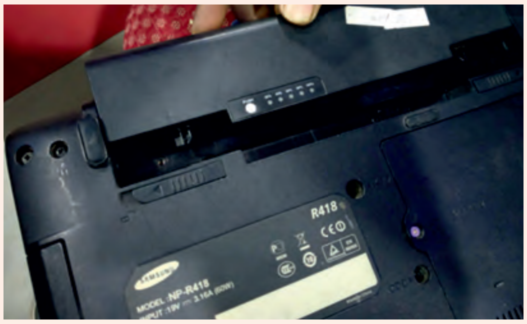


Fig. 1: Remove battery and optical drive

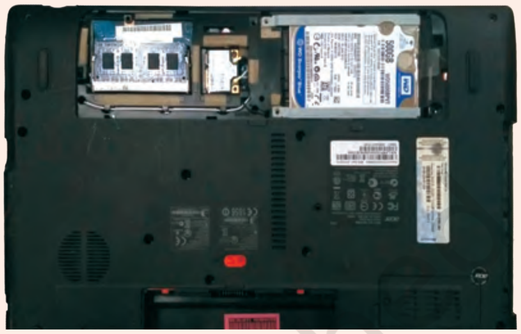


Fig. 2: Back panel of laptop

Step 2: Remove three screws fixing the hard drive bracket to the case. Disconnect the hard drive cable from the motherboard.

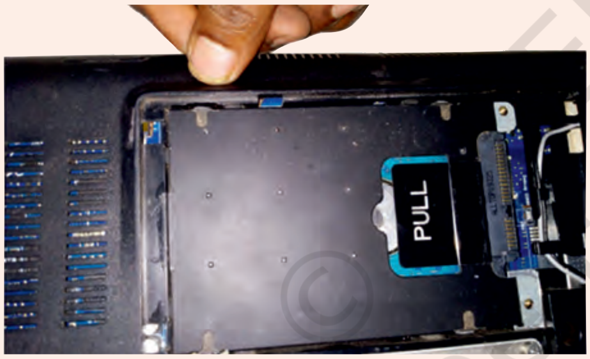


Fig. 3: Open connector and release hard drive cable

Fig. 4: Remove old hard drive assembly

Step 3: Remove the old hard drive from the notebook and replace with new hard disk.

SOLID STATE DRIVES

These do not have any moving components. They use only electronics to store and retrieve data. You can think of a SSD as a huge bank of random access memory (RAM). Most SSDs are non-volatile, meaning that they will not lose data when power is removed. The most common type of memory used with SSDs is flash-based RAM, the same type of non-volatile RAM used in

USB flash drives. SSD drives are lightning-fast when compared with mechanical hard drives. Additionally, they don't require motors to spin the platters and move the actuator, so they are lighter and draw less power. Mobile devices such as tablets, commonly use SSDs, and many hobbyists replace laptop hard drives with SSDs. With the price of memory continuing to fall, SSD drives have become very affordable. For example, you can purchase a 128 GB SSD drive for about the same price as a 2 TB mechanical drive. Some people use a SSD drive for the operating system and applications, and use a mechanical drive for data. Most SSD drives use SATA and will install just like any other SATA drive. In addition to SSD drives and USB flash drives, several types of flash memory are used in digital cameras and recorders, including the following:

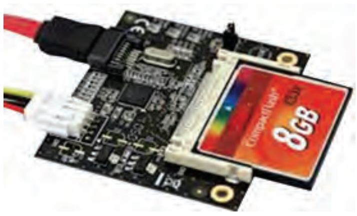


Fig. 10.8: Compact flash

Compact flash (CF)

These are manufactured by SanDisk and are very popular. The outer dimensions are 43 x 36 mm. Type I CF devices are 3.3 mm thick, and Type II devices (known as CF2) are 5 mm thick. They can hold up to 128 GB of data.

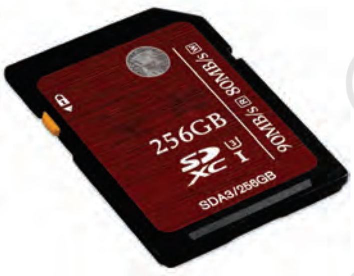


Fig. 10.9: SD Card

SD (Secure digital)

This is developed by the SD Card Association and is used with many types of portable devices as shown in Figure 10.9. It supersedes Multi Media Card (MMC) which is the same size. The dimensions of SD are 24 x 32 mm. They can hold up to 2 GB of data. Newer versions include SD high capacity (SDHC) and extended capacity (SDXC). SDHC can hold up to 32 GB, and SDXC can hold up to 2 TB of data.

Mini-SD

This is a smaller version of the SD card. The dimensions of mini-SD devices are 21.5 x 20 mm.

Micro-SD

This is the smallest of the three SD sizes. The dimensions of micro-SO devices are 15 x 11 mm.

xD

The xD Picture card is an older flash memory card used in some digital cameras. It was developed by Olympus and Fujifilm, but Olympus cameras are now using SD cards.

OPTICAL DISCS AND DRIVES

The modern PC comes with a DVD writer drive. The common types of discs which can be used in these drives include Blu-ray discs, different types of DVDs, and compact discs. An optical disc drive uses either electromagnetic waves or laser beams very close to the visible spectrum of light to write or read the data on optical discs.

Apart from the general and exclusive applications in a computer, the optical disc drives are used as DVD players, CD players, and DVD recorders. They are most extensively used in computers for various purposes like archiving of data, reading software, recording discs, and to distribute the consumer media for exchange purpose.

Table 10.2 Different types of optical discs and their capacities

Types	Capacity	Comments
CD-ROM	700 MB	The standard size is 12 cm (4.7 inch).
Mini CD-ROM	194 MB	The size is 6 to 8 cm.
DVD-ROM	4.7 GB	Dual sided DVD-ROM holds 4.7 GB on each side.
Dual layer DVD-ROM	8.5 GB	Dual sided dual-layer DVD-ROM holds 8.5 GB on each side.
Blu-ray single layer	25 GB	Blu-ray disk uses a blue laser, and CD and DVDs use a red laser.
Blu-ray double layer	50 GB	This is the common size used for movies. Triple layer holds 100 GB, and quad layer holds 128 GB.

Functioning of Optical Drive

The main components of an optical disc drive consist of an optical path, usually mounted on a pick up head and containing a semiconductor laser, the laser beam guiding lens, and the photodiodes which detect the reflection of light from the surface of the disc.

With the advent of more recent versions of optical discs, the wavelengths of the laser beams used in the process is changed from 780nm to 405nm in the Blu-ray disc.

The main aspects to be noted for the proper functioning of the CD drive are that, between the disc and the lens, a correct distance has to be maintained. Secondly, the beam should be focused on the laser spots of the disc. The data stored in spiral path will be accessed by moving the head all the way through the radius of the disc and keeping laser beam focused.

The mechanism by which the recorded encode the data on a disc is that by heating selectively the different parts of the dye layer by using the laser beam.

The reflectivity of the dye will be changed during this process leading to the creation of marks, represented by lands and pits on discs. The writer laser is more powerful than the reading laser.

With a higher speed in writing, less time will be taken by the laser to heat an area. The normal power is around 200 MW for the writing beam.

In rewritable discs, instead of dye layer, the crystalline metal complex used to cover the disc is melted with the laser beam. The lands and pits on metal alloy layer differ based on the extent to which the beam is exposed and can cause greater reflectivity.

In dual layered media, a polycarbonate layer separates the first semi-reflective layer and the second layer. The writing starts in the inner edge for the first layer and from the outer edge for the second layer.

Installing Optical Drives

Optical drive comes in different SATA versions such as SATA 1.0, 2.0, 3.0. Ensure that the SATA port is enabled in BIOS. SATA optical drive uses a SATA power connector.

Removing Discs without Power

There might be a time when you need to remove a disc from a drive but don’t have any power. It could be that the drive has failed and won't power up, or it could be you are disposing of an old computer and want to ensure that there isn't a disc left in the system. You can open the drive with a paper clip. All disc drives have a small pinhole in the front. Unbend a paper clip and poke it into the hole to manually open the drive.

Practical Activity

Installation of optical drive

Material required

Computer system, optical drive, screw driver

Procedure

- To install an optical drive, first check the position of the optical drive so that it aligns with the 5.25 inch drive bay.
- Insert the optical drive into the drive bay so that the optical drive screw holes align with the screw holes in the case (Figure 1).
- Secure the optical drive to the case using the proper screws (Figure 2).
- Connect the power cable coming from the SMPS to the power socket of optical drive (Figure 4).
- Connect SATA data cable from optical drive socket to the motherboard socket.
- Connect the SATA data cable to the optical drive as shown in Figure 4.
- Connect the other end of the SATA data cable to the motherboard as shown in Figure 3.

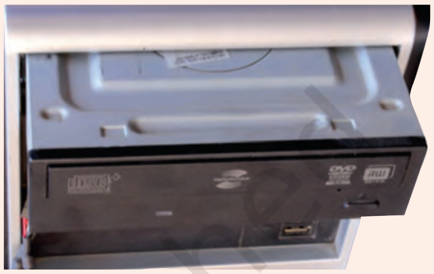


Fig. 1: Insert optical drive

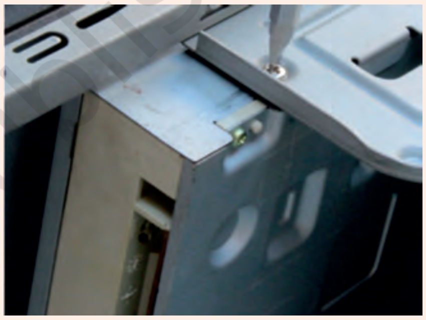


Fig. 2: Tighten screws of optical drive

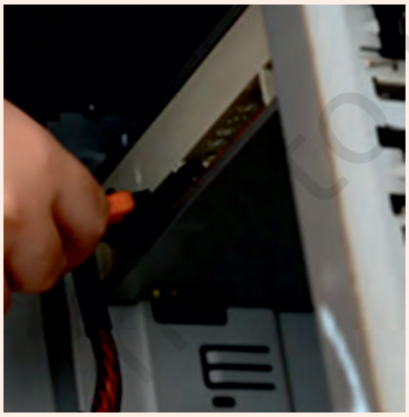


Fig. 3: Connect the SATA data cable

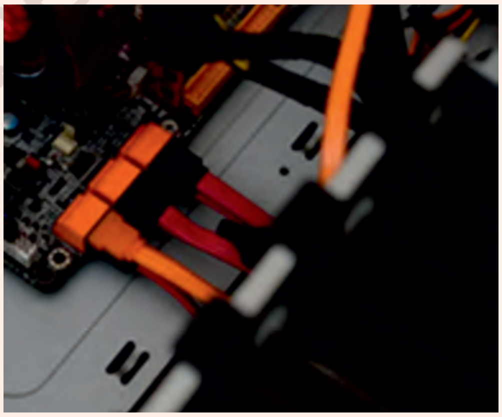


Fig. 4: Connect SATA data cable to the to optical drive motherboard

Disk Drive Interfaces

IDE/EIDE/PATA drives

Hard drive interfaces have gone through several changes and improvements over the years. Even though you will not see many of the older versions, if you understand a little about them, it makes it easier to understand current versions. The different disk drives are briefly explained below.

Integrated Drive Electronics (IDE)

These appeared in the 1980s and included drive controller electronics on the drive.

Advanced Technology Attachment (ATA)

IDE was standardised as ATA and later became known as ATA-1. The maximum drive size was 137GB. In earlier drives, the maximum was 2.1GB.

Extended IDE (El DE) and ATA-2

Modifications and enhancements of the original IDE were marketed as EIDE and later standardised as ATA-2.

ATA Packet Interface (ATAPI)

Originally IDE and ATA were designed only for hard drives. ATAPI provided standards so that EIDE and ATA versions could be used for other drives, such as CD-ROM and DVD-ROM drives.

Parallel ATA (PATA)

ATA was upgraded regularly to ATA-7, which also introduced Serial ATA (SATA). EIDE versions were renamed to PATA to differentiate it from SATA. PATA drives use direct memory access (DMA) transfers. DMA allows a device to directly access without the central processing unit (CPU), freeing up the CPU for other tasks. Ultra DMA (UDMA) appeared in ATA version 4 (ATA-4) and supported data transfers as high as 44 megabytes per second (MBps). ATA and UDMA were updated several times, and table below identifies the speeds and names for the different versions.

Table 10.3 Speeds of different versions of ATA

Type	Maximum Speed	Comments
ATA4	33MBps	Also called UDMA/33 and Ultra ATA/33.
ATA5	66MBps	Also called UDMA/66 and UltraATA/66.
ATA6	100MBps	Also called UDMA/100 and Ultra ATA/100. Maximum drive size increased to 144 PB.
ATA7	133MBps	Also called UDMA/133 and ultra ATA/133.

PATA

It's drives use ribbon cables similar to the one shown in Figure 10.10. Each ribbon cable includes three connectors, one for the motherboard IDE connection and two for the drives. In the Figure, the two IDE connectors (IDE 1 and IDE 2) are on the left, and the cable is lying on top of the motherboard. A typical PATA-based system would have two ribbon cables connecting a maximum of four drives. Early versions of PATA cables used 40 wires, but this was switched over to 80 wire cables with ATA-4. These extra wires provided signal grounds within the cable and supported the higher UDMA speeds. Even though the number of wires in the cables doubled, the connectors still have 40 pins. The maximum length of an IDE cable is 18 inches.

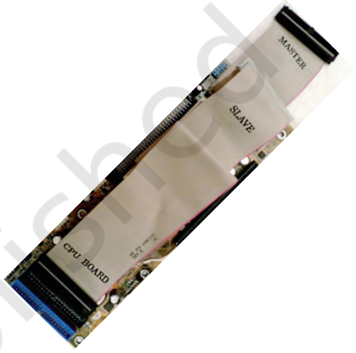


Fig. 10.10: PATA cables

PATA Connectors and Cables

All PATA connectors are 40-pin rectangular connectors, and they are the same on both the hard drive and the motherboard. Motherboards that support PATA typically have two connectors named IDE1 and IDE 2 as shown in Figure 10.11.

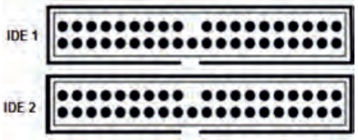


Fig. 10.11: PATA connector cable

Master and Slave Configuration

Each IDE connection supports two drives and these are commonly identified as master and slave drives. The system will try to boot to the master drive, but it does not automatically know which drive to select. Instead, you have to manipulate jumpers on the drive to let the system know which drive is the master and which is the slave. Figure 10.12 shows the back of an EIDE drive. You can see that it has a 40-pin connector for the ribbon cable and a Molex connector for power. It also has a set of jumpers used to identify whether the drive is the master or the slave.

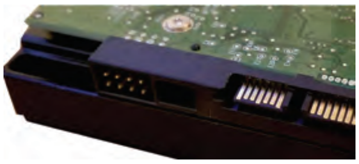


Fig. 10.12: Back of EIDE drive

If one is replacing or adding a drive, it is important to understand these jumpers. You will find a chart on the back of the drive, similar to the chart as shown in the Figure that identifies exactly how the jumper should be configured for each drive.

Cable Select

Cable select allows the system to identify the drive based on which connector is used. You can see that the end connector of the ribbon cable is labelled 'Master' and the middle connector is labelled 'Slave'. If you configure the jumpers for both drives to use 'Cable Select', they are identified based on which connector is used. If the drives are jumpered for 'Master' and 'Slave', the connector does not identify the drive.

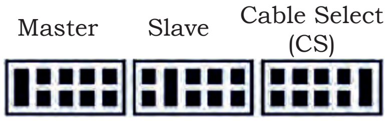


Fig. 10.13: Master and slave cable select

Serial advanced technology attachment (SATA)

Early data transmissions sent data between components one bit at a time, or serially. Engineers later improved this by sending multiple bits at a time to improve the speed. Therefore, data could be sent using multiple wires so that bits were next to each other or in parallel. The trade-off was that the cable needed more wires to send all the data at the same time. For example, a 40 pin EIDE ribbon cable includes 16 bits for data. If you send 16 bits at a time, you can send as much as 16 times more data than if you send just one bit at a time at the same speed. The idea that parallel is faster than serial held for many years, until a breakthrough with low voltage differential (LVD) signaling occurred. LVD signaling is a standard that transmits data as the difference in voltages between two wires in a pair. These differences can be rather small and engineers discovered they could send data serially along an WO cable quicker than they could with parallel. Many technologies use LVD signaling, including SATA drives, hyper transport used by AMD processors, and FireWire.

SATA generations

Three generations of SATA are currently in use. It is important to know the capabilities of each and also to recognise the different names that have been used. Table 4 below outlines the different versions and their speeds.

Table 10.4 Different versions of SATA and their speeds

Generation	Bit Speed	Byte Speed	Names
SATA 1	1.5 Gbits/s	150 MBps	SATA 1.5G, SATA 1.5Gb/s, SATA 1.5Gbit/s, SATA 150
SATA 3	3.0 Gbits/s	300 MBps	SATA 3G, SATA 3Gb/s, SATA 3Gbit/s, SATA 300
SATA 3	6.0 Gbits/s	600 MBps	SATA 6G, SATA 6Gb/s, SATA 6Gbit/s, SATA 600

PATA versions are commonly described using speeds rated in bytes per second (Bps), and SATA versions often use bits per second (bps). For example, SATA 1.0 can transfer data at 150 MBps, but it is commonly listed as 1.5 Gbit/s. One of the things that has confused people about SATA is the similarity of the names SATA 3.x and SATA 3G. Some products are marketed as SATA 3G, and customers think they are getting a third-generation SATA product. SATA 3G refers to a transfer rate of 3 Gbits/s provided by the second generation of SATA.

SATA and SSD (Solid State Drive)

Before SATA, hard drives were typically capable of sending data faster than the motherboard could accept it. The interface was the bottleneck. Even though each newer ATA version allowed faster data transfers, the drives were still faster than the interface. It is different with SATA 6G. You will not be able to find a mechanical hard drive that can transfer as much as 6 Gbits/second (or 600 MBps). Some extremely fast and extremely expensive hard drives can transfer data as quickly as 157 MBps. That is, these drives benefit from using

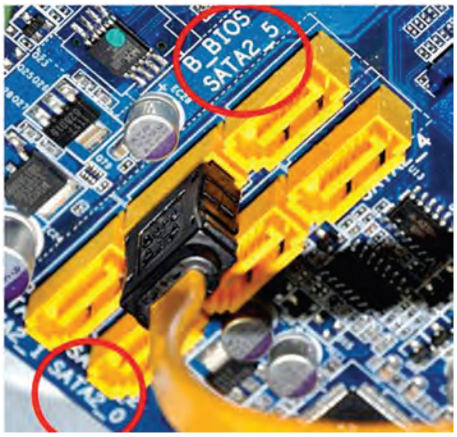


Fig. 10.14: SATA port in motherboard

SATA 3G but they never exceed 300 MBps, so they do not benefit from SATA 6G. You just will not see any performance difference in these hard drives if you plug them into a SATA 3G or SATA 6G port. With this in mind, you might be wondering, why would you want SATA 6G? The answer is, for solid state drives (SSDs). They are discussed later in this chapter, but in short, they don't have any moving parts and are much faster. Such are available that can read and transfer data as fast as 500 MB/s.

SATA data connectors and cables

SATA cables are much smaller than the 80 wire ribbon cables used with PATA. They include only seven wires, and cables can be as long as one meter (about 3.3 feet). A distinctive characteristic of SATA cables is that they have an L-shaped connector, which works as a key. Each drive is connected to a single SATA connector on the motherboard, so you don't have to worry about Master/Slave jumpers on SATA drives. Figure 10.14 shows part of a motherboard with five SATA ports. SATA 5 is on the left as a single unoccupied port. Ports 1 and 2 are stacked and ports 3 and 4 are stacked, allowing more ports in the same amount of space.

The colour coding for the wires is as follows:

(i) orange 3.3V to pins 1, 2, and 3,
(ii) black to pins 4, 5, and 6,
(iii) red 5V to pins 7, 8, and 9,
(iv) black for pins 10, 11 and 12, (pin 11 can be used to delay the startup of the drive or to indicate drive activity),
(v) 17 yellow 12V to pins 13, 14, and 15.

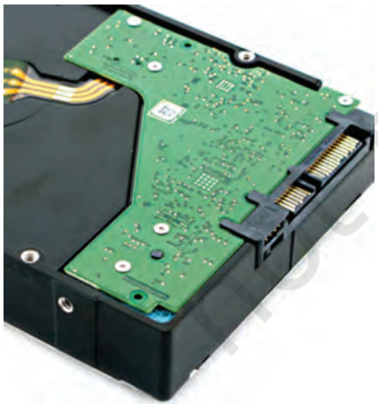


Fig. 10.15: Back of SATA HDD

Figure 10.15 shows the back of a SATA drive, along with the power cable from the power supply. The SATA data connection is on the right, and you can see that both have the distinctive L shaped key, although the power connector is larger. Also, the power connector has a square tip on one side.

Hot-swappable

All versions of SATA drives are hot-swappable, which means that you can plug in or remove the drive while the system is powered on. Several ground pins on the power cable are longer than the pins carrying voltage so that the ground pins connect first. This prevents any damage when they are plugged in. In contrast, you must power down a system before replacing a PATA drive. You are not likely to replace an internal SATA drive while the system is powered on. However, some systems have drive bays that allow you to plug in or remove a drive from the front panel or that are in an external enclosure. If a drive fails, you can swap it out without powering down the system.

Notes

Check Your Progress

A. Multiple choice questions

1. The concentric circles on the platter of hard disk are known as____________.
   (a) tracks (b) circles
   (c) sectors (d) None
2. ____________ is used for writing/reading of data to/from a magnetic ribbon.
   (a) Magnetic disk (b) Magnetic tape
   (c) Magnetic frames (d) Magnetic ribbon
3. The disk's surface is divided into a number of invisible concentric circles called____________.
   (a) drives (b) tracks
   (c) slits (d) references
4. Which of the following is not a part of disk address?
   (a) Sector size (b) Sector number
   (c) Track number (d) Surface number
5. Hard disk are organised as____________.
   (a) cylinders
   (b) tracks
   (c) cylinders and tracks
   (d) master boot record
6. Hard disk can have ____________ heads.
   (a) one (b) two
   (c) more than two (d) only one

NOTES

7. Hard disk drives are considered ____________ storage.
   (a) flash (b) non-volatile
   (c) temporary (d) non permanent
8. Which of the following can hold data of at least one GB?
   (a) Hard disk (b) CD-ROM
   (c) Floppy disk (d) None of these
9. The hard disks record information by____________.
   (a) centrifugation (b) propagation
   (c) gravitation (d) magnetisation
10. Reading data is performed in magnetic disk by________.
   (a) read/write leads (b) sectors
   (c) track (d) lower surface

B. Fill in the blanks

1. The hard disk drive (HDD) is the _________ long-term storage device used in personal computers.
2. A hard drive is divided into one or _________ partitions.
3. A portable HDD can be attached to the computer externally through a ____________.
4. Data is transferred from the _________ platter through the read/write (R/W) head to the computer.
5. A HDD consists of multiple flat circular disks called _____________.
6. The controller is a printed circuit board, mounted at the bottom of a ___________.
7. Each platter of the hard disk is logically divided into many concentric circles known as _____________.
8. A cylinder is the set of identical tracks on both surfaces of each drive ______________.
9. Each track is logically divided into sections known as __________.
10. The data on hard disk is stored in the magnetic domains on the _____________ material.
11. The data rate is the number of bytes per second that the drive can deliver to the ______________.

C. State whether the statements are True or False

1. Magnetic disk is a sequential access device.
2. A hard disk drive fits outside a computer case.
3. During the life of a disk, is it true that defragmentation of the file system can significantly improve performance.
4. Serial data access is faster than direct data access.
5. Storage devices are hardware that reads data and programs from storage media.
6. Capacity of a storage device is usually measured in terms of meter.

7. Flash memory cards are credit card sized solid-state storage devices, which are widely used in notebook.
8. Writing is the process of saving information to the secondary storage device.
9. Optical disc storage devices have no moving parts.
10. Capacity of a storage device is usually measured in terms of bytes.

D. Short answer questions

1. What do you understand by a hard disk drive?
2. What are the physical components of a HDD?
3. What are the logical components of a HDD?
4. Explain the working of a hard disk.
5. What are the parameters to measure of disk drive performance?
6. List down the different types of HDD.
7. What are the different versions and the speeds of SATA drive?
8. Describe hard drive characteristics.

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